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RESEARCH ARTICLE

Somatometric Characteristics of the Grey Wolf (*Canis lupus*) in Bulgaria

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Abstract

Grey wolf (*Canis lupus* Linnaeus 1758) is the largest representative of the Canidae family in Bulgaria. It inhabits almost the whole territory, most frequently the mountainous and hilly areas. The grey wolf is a hunting species in the country. Despite this, there is little information in the literature on its size. The aim of this work was to provide the first systematized data of the somatometric characteristics (weight – P; total body length – L; length of the body to the base of the tail – Lb; tail length – Lo and height at the withers – Hb) of the grey wolf in Bulgaria and to establish what is the degree of their sexual dimorphism. We found that the adult males are 24.3% heavier than the females ($t=4.46$; $p<0.001$). They also have a longer body by 8.8% ($t = 3.66$; $p<0.001$) and a greater height by 6.5% ($U=546$; $p=0.005$). The smallest difference (6.2%) between the two sexes was observed in tail length ($U=629.5$; $p=0.03$). The results of our study support the clear sexual dimorphism established in other wolf populations. Further studies are needed to link the wolf's body size data with prey type data in the respective areas for more clarity. This will be beneficial both for better wolf population management and for the accumulation of a database.

Keywords
carnivora, body size, sexual dimorphism

Introduction

The grey wolf (*Canis lupus* Linnaeus 1758) is a widely distributed species – from North America (Canada, Alaska and Northern USA), Europe (except the United Kingdom and Ireland) to Asia (Mech, Boitani 2004), and inhabiting different habitats (Boitani

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et al., 2018). Therefore, the variation of its phenotype (size, color and weight) is remarkably high. Based on this variability, several subspecies of Canis lupus have been distinguished (Boitani, 2000), with two subspecies recognized for Europe – *C. l. signatus* (Iberia) and *C. l. italicus* (Italy, France and Switzerland). Despite the widespread distribution of the wolf in the literature, there is little data on its weight and body size. A significant part of the articles found on the subject of the Euro-Asian part are by Russian authors (Ognev, 1931; Zworykin, 1939; Geptner, Morozova-Turova, 1951; Geptner et al., 1967; Bibikov, 1985), which were conducted decades ago. More recent data on wolf weight and body size in Europe are presented by Anderson (2002) in Latvia, Čomor, Čanády (2011) in Slovakia, Platiša et al. (2014) in Croatia and Trbojević, Ćirović (2016) in Serbia and Bosnia and Herzegovina.

In Bulgaria the grey wolf is the largest representative of the Canidae family and the second largest predator in the country, after the brown bear (*Ursus arctos* Linnaeus 1758). It inhabits almost the whole territory of the country, most frequently the mountainous and hilly areas. It is assumed that Bulgaria is inhabited by the nominate subspecies (*Canis lupus lupus*), which is medium-sized and belonging to the Dinaric-Balkan population (Atanasov, Peshev, 1963; Chapron et al., 2014). It is an all-year-hunting species in the country, especially on the territory of the game breeding stations. However, studies on the weight and body size of Bulgarian wolves are considerably few and fragmentary (Boev, 1997; Spassov et al., 2000; Tsingarska et al., 2014).

The aim of this work was to provide the first systematized data of the somatometric characteristics of the grey wolf in Bulgaria and to establish, what the degree of their sexual dimorphism is.

Material and methods

The data were collected mainly from Stara Planina Mountain, Rhodopes Mountain and Osogovo Mountain. The relief is diverse and the climate is predominantly temperate continental. The terrain is hilly or mountainous with large massifs of deciduous European beech (*Fagus sylvatica*, Linnaeus 1753), oak (*Quercus* sp.) and coniferous Norway spruce (*Picea abies* (Linnaeus) Karsten 1881) and Silver fir (*Abies alba* Miller 1759) forests (Stefanov, 2002). Of the ungulate species, red deer (*Cervus elaphus* Linnaeus, 1758), roe deer (*Capreolus capreolus* Linnaeus, 1758), and wild boar (*Sus scrofa* Linnaeus, 1758) are found in these areas. The wild goat (*Rupicapra rupicapra* Linnaeus, 1758) occurs as well but its distribution is more limited.

The data was collected during the period 2004-2020. All measurements were taken only on dead individuals, legally hunted according to the Bulgarian hunting law. Only adult individuals (>2 years) were used for this study, whose age was determined by hunters according to the body size and tooth wear (Gipson et al., 2000), not taking into account the weight of stomach contents. The analysis includes the following measurements: weight (P), total body length (L), the length of the body to the base of the tail (Lb), tail length (Lo) and height at the withers (Hb) (Figure 1).

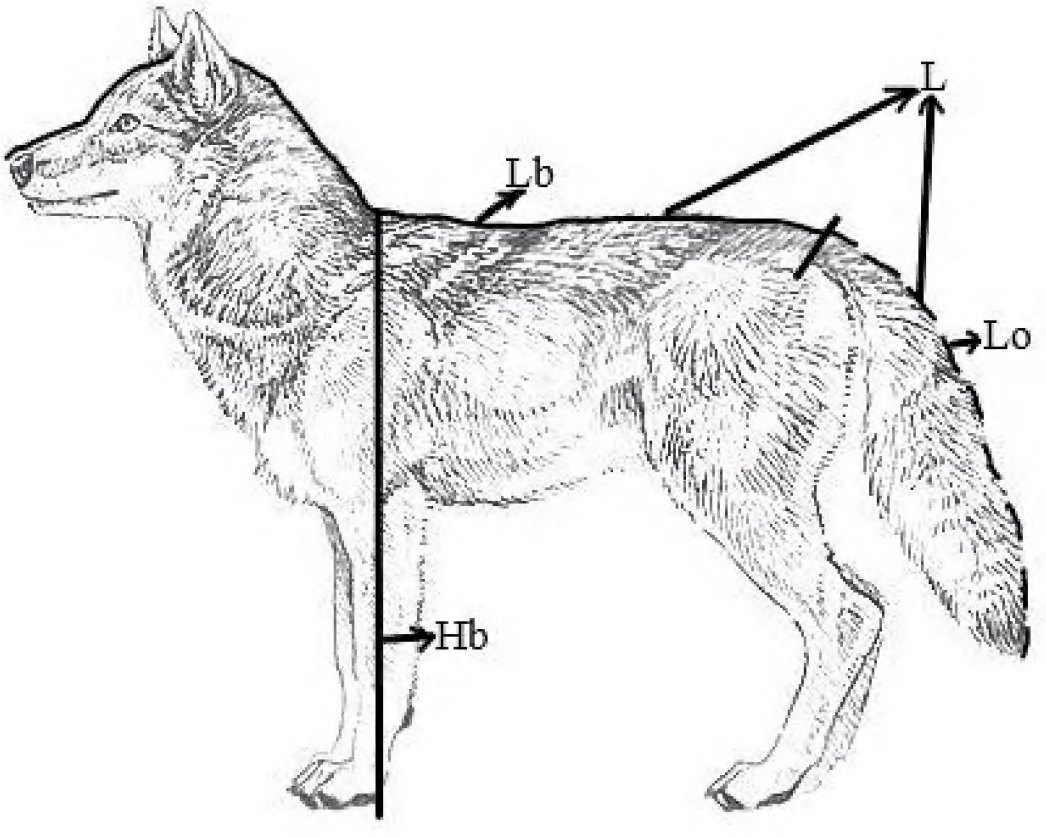

Figure 1. Scheme of the somatometric measurements of the wolf (after Platiša et al., 2014): L – total body length, cm; Lb – the length of the body to the base of the tail, cm; Lo – tail length, cm; Hb – height at the withers, cm.

We took off all 5 parameters of 89 individuals (60 males and 29 females). The sexual dimorphism was assessed as a percentage of difference according to the following formula (Hillis, Mallory, 1996):

Statistical analyses

All statistical processing was performed in R v. 4.3.0 (R Core Team 2023). The distribution of data was tested with the Shapiro-Wilk test. For normally distributed data (Shapiro-Wilk test, $p>0.05$) Student's t-test was used. Two of studied parameters (Hb and Lo) showed non-normally distribution (Shapiro-Wilk test, $p<0.05$), so the non-parametric test of Mann-Whitney was used.

To express the ratio between the studied parameters of both sexes, we created indices following Čomor, Čanády (2011):

1. Index of the weight in relation to the length of the body (P*100/Lb);
2. Index of the weight in relation to the height of the body (P*100/Hb);
3. Index of the height of the body to the body length (H*100/Lb);
4. Index of the length of the tail to the body length (Lo*100/Lb);

All statistical differences were assessed at the significance level of 0.05.

Results

The results indicate a clear sexual dimorphism in Bulgarian wolves. The adult males are 24.3% heavier than the females (t=4.46; p<0.001). They also have a longer body by 8.8% (t = 3.66; p<0.001) and a greater height by 6.5% (U=546; p=0.005). The smallest difference (6.2%) between the two sexes was observed in tail length (U=629.5; p=0.03) (Table 1). We found a significant statistical difference for both sexes in the index values P*100/Lb (t = 3.27; p = 0.002) and P*100/Hb (U=531.5; p = 0.003). The sex difference was 14.4% and 17.1%, respectively, due to the higher values in the ratio of the two indices in males. No statistical difference was found in the latter two indices (p > 0.05), and the low sex difference that was observed was due to the higher values in the ratio of the indices in the females (Table 1).

Table 1. Descriptive statistics of body measurements of grey wolves in Bulgaria, sex difference (%) and statistical significance of the differences by sex (Student's t-test and Mann-Whitney U test).

Parameters	Sex	N	Min-Max	Mean	SD	CV	% difference	Statistical test	P
P	M	60	15-57	37.8	7.3	19.4	24.3	t=4.46	<0.001***
	F	29	15-45	30.4	7	23.1			
Hb	M	60	46-81	68.4	7.8	11.4	6.5	U=546	0.005**
	F	29	54-79	64.2	5.8	9			
Lb	M	60	100-155	125.2	12.5	10	8.8	t = 3.66	<0.001***
	F	29	87-136	115.1	11.8	10.3			
Lo	M	60	31-49	40.9	3.2	7.8	6.2	U=629.5	0.03*
	F	29	30-46	38.5	4.4	11.5			
L	M	60	137-198	166.1	13.3	8	8.1	t=4.24	<0.001***
	F	29	119-171	153.6	12.6	8.2			
P*100/Lb	M	60	13.9-43.2	30.1	5.1	17	14.4	t = 3.27	0.002**
	F	29	17.2-39.8	26.3	5.1	19.4			
P*100/Hb	M	60	32.5-80	55.4	10.2	18.5	17.1	U=531.5	0.003**
	F	29	26.8-62-9	47.3	9.5	20.1			
Hb*100/Lb	M	60	41.5-70.2	55	7.5	13.5	-2.3	t = 0.76	0.45
	F	29	44.9-72.5	56.3	7.2	12.9			
Lo*100/Lb	M	60	25.5-42	32.9	3.9	11.9	-2.7	t = 0.89	0.38
	F	29	25-47.3	33.8	5.2	15.5			

Note: Level of statistical significance: *p < 0.05; **p<0.01; ***p<0.001.

Discussion

In this research we established a clear sexual dimorphism in the weight and body sizes of the Bulgarian grey wolves. According to us the wide variability observed in the studied parameters is due to the subjective error in the estimation of the age of the wolves by the hunters and also to the non-consideration of the weight of the gastric contents. However, the presented results can be the basis for a more in-depth study. The results obtained from us are in accordance with other studies (Hillis, Mallory, 1996; Anderson, 2002; Trbojević, Ćirović, 2016).

We found an average weight of 37.8 kg and 30.4 kg for male and female wolves, respectively, which are similar to those reported by Tsingarska et al. (2014) for South-western Bulgaria. Among the other populations also belonging to the Dinaric-Balkan population, similar body sizes of wolves are reported in Serbia and Croatia (mean weight: male – 34.8-36.7 kg and female – 28.7-30.8 kg), while in Bosnia and Herzegovina they are bigger (mean weight: male – 40.5 kg and female – 34 kg) (Platiša et al., 2014; Trbojević, Ćirović, 2016). According to Trbojević, Ćirović (2016) this is due to the Drina River which separates populations into the bigger and heavier form from Bosnia and Herzegovina, and the smaller and lighter form from Serbia.

Generally, the grey wolves from the Carpathian population are larger. A comparative study on the skulls of individuals from the two populations (Carpathian and Dinaric-Balkan) confirms this assumption (Milenković et al., 2010). However, the grey wolves from East Slovakia have similar sizes (the mean wolves' weight is 39.9 kg of males and 34.9 kg of females) (Čomor, Čanády, 2011) as those from Bosnia and Herzegovina. Differences in the sizes are also observed in the grey wolves of the Baltic population inhabiting Latvia (Anderson, 2002) and South Lithuania (Špinkytė-Bačkaitienė, Pėtelis, 2006). The individuals from Latvia are larger (mean weight of male – 41.2 kg and of female respectively – 34 kg) and have similar sizes like those from Bosnia and Herzegovina. The grey wolves from South Lithuania are smaller (mean weight: male – 35.9 kg and female – 26 kg) and their sizes are close to our results and those from Serbia and Croatia.

The largest wolves in the published literature reach 80 kg (Ognev, 1931; Zworykin, 1939; Geptner et al., 1967; Bibikov, 1985). In the Baltics, Anderson (2002) writes about wolves that were shot, whose weight ranged between 67-74 kg, even up to 82 kg. These higher values of the northern wolf populations are in accordance with Bergmann's principle (Bergmann, 1847), stating that populations of larger size are found in colder climates. Although less common, large individuals are also shot from populations inhabiting more southern areas, such as the five adult males described by Boev (1997) weighing 41-66 kg and the three adult male wolves mentioned by Spassov et al. (2000) weighing 60 kg, 72 kg and 75 kg.

Conclusion

In this study, we presented the first systematic data about weight and body size of the Bulgarian wolves. We found that they have a clear sexual dimorphism. Further studies are needed to link the wolf's body size data with prey type data in the respective areas for more clarity. This will be beneficial both for better wolf population management and for the accumulation of a database.

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